



Ø BEAT

COLO. SPRINGS,
COLORADO

JULY 1983

Talking On Shooting Star?

METEOR-BURST COMMUNICATIONS BOUNCE SIGNALS BETWEEN REMOTE SITES

by Willis E. Day, Scientific Radio Systems, Rochester, N.Y.

Part One

Bouncing radio signals off ionized trails formed by small meteors entering the upper atmosphere can provide reliable, cost effective communications channels. No pie-in-the-sky concept, the technology involved has been put into practice in several working systems.

The technique, called meteor-burst communications (Fig. 1), provides automatic time multiplexing of many signals that are extremely difficult to jam or intercept. Using computer technology for packet formatting, buffering, and error correction, compact and flexible meteor-burst systems can now make possible many data-communications and -acquisition applications unserved by traditional channel.

METEORS AS ANTENNAS

The operational scenario for a meteor-burst communications system comprises a master station and one or more remote stations. Alternately, the system could consist of multiple master stations and any number of remote installations. The master incorporates sufficient intelligence to find a meteor trail off which to bounce the transmissions; but because a given trail lasts only a fraction of a second, the master must capture new trails off which to bounce successive packets of data.

Shower meteors are the most spectacular type of this phenomenon and are best known because they arrive on a regular basis. However, they account for a small fraction of the meteors that are available for radio communications. Meteors with a diameter as small as 1/32 inch occur at a rate of 2 to 8 billion a day, or 50,000 a

second. The ionized trails of these numerous particles provide the directional antennas for radio signals.

Most of the meteors used have orbits that coincide with the earth's. When such a meteor catches up with, or is overtaken by, the earth, it enters the atmosphere at a speed of 10 to 75 kilometers per second, thus possessing a large amount of energy. As the meteor collides with air molecules, the energy changes to heat, which vaporizes the particle. The velocity of the vaporized atoms is further restricted by air molecules, which ionize them by stripping electrons from the atoms. The ionization causes a trail of positive-charged ions and free electrons to form behind the meteor.

This trail will redirect radio waves in one of two ways, depending on its electron density — which is proportional to the size of the meteor. Such trails may be categorized as overdense or underdense, with a density of 10 to the 14th power electrons per meter being the crossover. Overdense trails are so dense that the radio signal does not penetrate and thus is reflected. When the trail is underdense, the radio signals pass through, exciting electrons that then act as small dipole antennas and reradiate the signal.

The ionized trail is distributed in the form of a long thin paraboloid. The radius of the trail's head is about 1 meter, with a trail length of about 25 km. The trail's speed and size determines the length of time the communications system can use it before having to switch to another such trail. Typically, a meteor trail will permit useful communications for several hundred milliseconds.

Both overdense and underdense trails act as directional antennas, reflection from which is equal to the signal's angle of incidence. The area of reception or "footprint", of a typical trail is about 5 miles wide by 25

(continued on page 4)

P.P.R.A.A. DIRECTORS

PRESIDENT	*Dave Vierling NØDV 2511 N. Tejon 80907	473-0293
V. PRESIDENT	*Charlie Biggs KCØTI 302 Quebec 80911	392-1476
SECRETARY	Mark Richardson NØEPF 24 N. Union 80909	473-1799
TREASURER	*Les Borst KCØNC 2542 E. Bijou 80909	634-399
Board Member	Bud Libengood NØDDF 384G W. Rockrimmon 80919	599-7699
Board Member	Tom Weatherly ADØO 2010 N. Carlton 80909	475-0192
Board Member	Karl White K4DQ 4460 Nonchalant Circle 80917	597-4805
Board Member	*Jake Jacobs NØCYR 104 Old Broadmoor Rd. 80906	634-2223

ZERO BEAT is published monthly in the interest of the members of the Pikes Peak Radio Amateur Association, Inc., Colorado Springs, Colorado. Permission is given to reprint articles or excerpts provided credit is given. Deadline for submission of articles is the 21st of the month. Classifieds accepted anytime.

The Pikes Peak Radio Amateur Association meets on the second Wednesday of every month at the Palmer House Motel, I-25 and Fillmore, at 7:30 p.m. All amateurs and interested parties are invited to attend.

Editor: Don Lohse KBØKQ, 1410 E. LaSalle, Colorado Springs, CO 80907 635-7469

MEETING MINUTES

The July 8, 1983 meeting of the Pikes Peak Radio Amateur Association was called to order at 7:40 p.m. at the Palmer House. 55 members and guests were present. After introductions, Les, KCØNC, reported that the treasury had a balance, after expenses, of \$2833.49. Greg, KAØFOZ, reported that investigations into RFI complaints are continuing.

New novice classes are to begin around the 3rd week in September.

Dave, NØDV, publically gave a thank you to AES Communications for their fine service to the ham community. He also announced that Colorado now has a new section manager. He is Bill Sheffield, KQØJ. The letter he sent indicated there are several local and state positions open to those willing to serve. Interested persons should contact Dave for more detailed information.

Mark, NØEPF, reported that an Amateur Radio public service announcement is being aired on Channel 13.

Ed Means updated the status of Amsat Phase IIIB which had a scheduled launch date of 16 June. (The launch was on schedule and successful). For information on operations a \$1.00 donation should be sent to Amsat, 221 Long Swamp Road, Wolcott, Conn. 06716. Parties should request publication ASR #57.

After the break, the drawing was held. Ken, WØTGL, then reported on the progress of plans and missions for the Sports Festival. Dave, WDØSSG, indicated there were only a few events left to be filled. Steve, NØST, reported that progress on antenna placement is continuing. Members can pick up their packets at the OTC beginning June 14.

There being no further business, the meeting adjourned at 10:11 p.m. The next meeting will be July 13 at the Palmer House.

Respectfully Submitted,
Mark Richardson, NØEPF

FOR SALE — ASR model 28 printer (60-75 & 100 wpm Teletype Corp. tape cutter and reader—\$350. Slope face operators position and rack, with Collins phone patch and station control. Built in reflectometer and view meter—\$100. Central Electronics 100V transmitter, SSB, CW, phase modulation, double side band and RTTY (broadband tuning)—\$200. 600L broadband linear amplifier—\$200. 390A Collins general coverage receiver (mint) with manual—\$350. Technical Material Corp frequency shift convertor (with dual diversity)—\$54. 755C3 Collins receiver (mint) with manual—\$900. Onan 3.5 KW 4 cylinder skid mounted generator—perfect for field day or cabin—\$250. Call Pete WØVI for appointment to see. 475-9666.

FOR SALE — HW 101 w/ p.s., CW filter & spkr w 2 extra pair of finals including brand new heavy duty 6146W's—\$300. Conrac dual input high resolution monitor \$75. Tom Weatherly ADØO 475-0192.

If it's CW, it's communications.

832-	ALL MAJOR BRANDS	832-
1111	SALES-SERVICE	1111
8-530 Mon.-Fri. 8:30-1 Sat.		

NØRT KØMFTV MIKE WØØEKE BOB KØLGF RUS WØØWIL
John WAØA DV

CW

C W ELECTRONIC SALES CO.

800 Lincoln St., Denver, CO 80203

TO ALL HAMS PACKET RADIO KITS

The Tucson Amateur Packet Radio group (TAPR) will soon have the Terminal Node Controller (TNC) kits available. The design has undergone some revisions as a result of Beta Test input, and a new layout is being done. The major changes are an increase in both RAM and ROM, and some modifications to the modem. The price for the kits is currently estimated to be \$240 plus shipping.

In order to ensure the best possible results with the kits TAPR will be making up a limited edition of about 25 boards and parts sets for a final test. The TNC has evolved into a fairly complex little computer, with about 30 ICs. Because of the tight schedule and complexity of the project only technically qualified persons with Beta Test TNC experience and radio/computer interface experience have been accepted by TAPR for this final test.

Assuming that everything goes well during the "final test" TAPR will need to know as soon as possible what the demand for TNC kits will be. To help plan parts deliveries and to schedule shipments in an equitable fashion, TAPR will take \$25 deposits toward kits, which should be available in September. Upon receipt of a person's deposit, he will be placed on a list. About two weeks before they expect to be able to ship his TNC, they will notify the purchaser to send the remaining payment and the kit will be sent upon receipt of this payment.

Although all kit purchasers will be required to sign a disclaimer similar to the one used for Beta Test, TAPR will be able to provide a 30-day parts warranty. They will not restrict kit distribution to TAPR members, although there may be some preference given in shipment priority. However, any hardware and software support

(continued on page 5)

Channel Communications Inc.

20-G EAST MOUNTVIEW LANE
COLORADO SPRINGS COLORADO 80907

(303) 598-6704

- COMMERCIAL & PERSONAL 2-WAY MOBILE RADIO
- USED & CONSIGNMENT HF, VHF, & UHF COMM. EQUIPMENT
- REPAIR & CALIBRATION OF COMMUNICATIONS & OTHER ELECTRONICS EQUIPMENT

Dick Kohlhaas, W5UDM

BOARD MINUTES

The board meeting of the Pikes Peak Radio Amateur Association was called to order June 13, 1983 at 7:40 p.m. in the home of Karl, K4DQ. Present were Karl, K4DQ; Mark, NØEPF; Bud, NØDDF; Jake, NØCYR; Dave, NØDV; and Charlie, KCØTI.

Mark reported that the club has been officially reactivated with the ARRL.

The picnic will be held Aug. 7th at Black Forest Pavillion #1. Drinks, chips, and charcoal will be provided by the club as in the past. It will be BYOB (Bring Your Own Beef).

Bud will give a DDF antenna kit to the first three people who contact him and who will make it. The board is also continuing to look into the club insurance matter.

Elections are scheduled for the October meeting. If someone is interested in serving, he/she should contact a board member.

The coffeepot has disappeared. Les volunteered to locate one for purchase at a reasonable price.

Swapfest — Les moved, Charlie seconded that \$500 be allocated for next year's prizes. The motion passes unanimously. The board also felt the Polka Club should be reserved for next year. A date will be chosen soon.

Post office box — Jake moved, Dave seconded to obtain a club post office box for six months (the minimum). The motion passed unanimously. (Les, KCØNC, has since obtained such a box).

Concern was noted over the parking problem at the OTC. A fire-lane must be maintained. Hams should park along the north fence.

Concern was also expressed over the cost of the room at the Palmer House. Tom will be asked to contact the management to see if a lower price can be negotiated.

A fox hunt will be held August 7th in conjunction with the picnic.

There being no further business before the board, the meeting adjourned at 9:40 p.m. Next meeting will be at Bud's new QTH: 6931 Karl's Kourt July 18. Talk in on .52.

Respectfully Submitted,
Mark Richardson NØEPF

GC ELECTRONICS

GTB SYLVANIA

EGG SEMICONDUCTORS

Channel Master

THORDARSON

HANDY

COLORADO SPRINGS

WALKER ELECTRONICS

2838 NORTH PROSPECT ST.

COLORADO SPRINGS, COLORADO 80907

PHONE - (303) 636-1661

CHEMICALS—TOOLS

WIRE AND CABLE

SERVICE AIDS

MICROPHONES

WHOLESALE DISTRIBUTORS

EXPERIMENTERS ITEMS

HEADPHONES—SPEAKERS

ANTENNA INSTALL. MATERIALS

LEADER

Instruments Corp.

Regency

**ELECTRONIC PARTS
SOFTWARE**

**B & B
COMPUTER PACKETS**

3011 N. El Paso
Colorado Springs, CO
(303) 630-1122

**Bring Your Catalogs In And
Compare Our Prices**

METEOR (cont.)

miles long. This fixed-path geometry, coupled with irregular arrival of meteors, allows natural time-division multiplexing.

When a meteor appears at the proper location, it reflects or reradiates the master station's signal to a remote station. If the address coding is correct, the remote station turns on its transmitter and uses the established path for communication with the master station.

A system operated for several years by Allied Forces in Europe studied propagation and signal-interception characteristics. It proved that even with directional antennas, stations in close proximity did not receive the same messages at the same time because their reception footprints were different. This highly localized footprint makes meteor-burst communications systems extremely difficult to intercept or jam.

As shown in Fig. 1, the useful meteor trails exist 85 to 115 km above the earth. The geometry of the meteor trail, taken in conjunction with the curvature of the earth, provides a communications range from essentially 0 to about 2000 km.

WAITING FOR THROUGHPUT

The capability of meteor-burst systems can be specified in terms of data throughput or in terms of the amount of waiting time required to transmit a message between two stations at a specified reliability. For event reporting, the waiting time before a single station can be contacted may be a critical parameter. For teleprinting transmission, the data throughput is usually more important than the waiting time.

The primary parameters that affect system performance include: operating frequency, transmitter power, antenna gain, receiver threshold level, and desired data rate. All of these factors should be considered when designing meteor-burst communications systems.

Meteor trails will reflect signals between 30 and 200 MHz. The preferred band is 40 to 50 MHz as above 50 MHz, signal attenuation increases rapidly and below 40 MHz, larger antenna size adds cost to the system.

Increasing the transmitter power reduces the message waiting time by allowing use of trails generated by smaller meteors. Current off-the-shelf equipment uses 1000 watts at the master station and 300 watts at the remote stations. (Editor: 6 meter meteor pack stations?!!!)

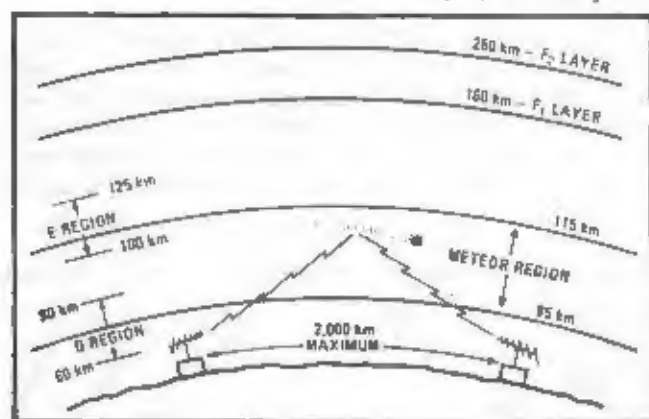
TRADEOFFS IN ANTENNA GAIN

Increasing antenna gain nominally decreases the message waiting time. However, the narrower beamwidth of higher-gain antennas diminishes sky coverage and reduces the number of usable meteor trails. The practical limit of antenna gain is a function of operating range and environment. Usually a five-element Yagi antenna is used at the master station with dipoles or smaller Yagis utilized at remotes. Gain figures of 10 dB over isotropic have been used with good results.

RECEIVER TRADEOFFS

Receiver threshold is defined as the signal level required to achieve a particular Bit-Error Rate (BER) with the type of modulation employed, receiver noise figure and site noise level taken into account. The lower the receiver threshold, the shorter the waiting time. A typical receiver threshold for a system operating at 45 MHz and using coherent biphasic phase-shift-keying (PSK) modulation at 4 kilobits per second would be -114 dBm to obtain a BER of 1/1000.

(From *ELECTRONICS*,
December 29, 1982, pp. 71-79)
Thanks to QSP, February 1983



1. Meteor-burst geometry. Communications channels use the highly ionized trails of tiny meteors to reflect radio waves. This highly directional path geometry, coupled with the irregular arrival of meteors, facilitates natural time-division multiplexing and good security.

**Centennial ★ ★ RCA
ELECTRONICS**

2324 East Bijou, Colorado Springs, CO 80909
PHONE: (303) 633-4666

BK PRECISION

The Cooper Group,

BELDEN

**GC
ELECTRONICS**

MALLORY

TRW

VIZ

A.R.R.L.

Largest Supply of Electronic Parts
in Southern Colorado

MILEY'S RADIO

Jess KOTAA 719 W. 7th St. Florence, Colorado 81226 784-3040
Hours 8 to 5 and 7 to 9 Tuesday through Friday — 8 to 1 on Saturday. Closed Sunday and Monday.

NEW EQUIPMENT IN STOCK

Kenwood TS 930S Sale \$1375 w/tuner \$1530.
Kenwood TS 430S \$775.
430 Power Supply \$134.
Yaesu FT 102 \$910 to your door.
Icom 740 \$940 — \$50 Icom rebate & free internal AC supply—\$145. value
Icom 730 \$645
Kenwood TR-7950 45W List \$439 - sale \$345.
Kenwood TR 2500 HT \$273.
Kenwood 7930 \$314.
Kenwood TW 4000A 144 & 440 \$540 w/voice synth. installed \$595
New Santelec 144uP 2 M HT-Best HT on the Market \$279.
Santelec 440 uP 440 Mhz HT \$279.
Santelec (Tokyo Hi Power) 32V 30 watt 2 mtr FM SSB amp \$69.
Santelec (Tokyo Hi Power) 30V amp \$59.
Santelec (Tokyo Hi Power) 160V/25w drive — List \$349 Sale \$289
Santelec (Tokyo Hi Power) 160V/10w drive — List \$349 Sale \$289
Icom 2AT HT Reg. \$269 Now \$219.
Icom 2A Reg. \$239 Now \$214.
Icom IC 4AT 440 MHz HT \$249.
Icom 45A 440 MHz mobile \$345.
Icom 25H — 45 W \$340.
New Icom 25AC Green readout \$310.
Extra Icom batteries, chrgs. & etc. in stock.
New Azden PCS 4000 \$275.
New KDK 2030 mini 25W w/TTM \$270.
New Azden PCS 300 HT \$265.
New Yaesu FT 77 solid state HF Xcvr. \$549.
Yaesu FT 208R 2 mtr. synth. HT \$275.
Tempo 151T 1 & 5 W 2 mtr. HT — 140-150MHz w/16 button
TTP \$285. Leather Case for Tempo \$24. HM 15 spkr mic
for Tempo \$34. ALL THREE \$340.
Kantronics interface for VIC 20 and others \$146.
Kantronics Hamsoft for VIC 20 \$46.
Kantronic Hamtext for VIC/Com 64 \$90
Commodore 64, VIC 20, and all peripherals available — Call
for info and our low prices.
AEA CP-1 "Computer Patch" interface. 1 in stock. List \$239 Sale \$189
Commodore 1701 color monitor \$275

USED EQUIPMENT

m 211E-FM/SSB/CW 2 meter \$295
Icom RM-2 Mem Scan control for 211E \$100
Icom 25A w/2 mounting brackets-exc. cond. \$245.
Icom 290A 2 meter all mode \$375.

Icom 21A AC/DC 2 meter FM w/digital VFO \$150.
Icom 230 synth. 2 mtr. \$135.
Icom 245 in excellent condition \$145.
Azden PCS 300 HT \$200.
Two Yaesu FT 227R & 227RA 2 mtr. FM mobile \$135 each.
Swan 200-SS-16-B 80-10m, solid state w/ps 20-20 amp continuous
power supply-VOX, CW, 16 pole filter, 150W output on TS-80, 100W
out on 10 \$425
Swan 1200W linear \$225.
Hygain TH3 3 element tribander \$150.
Galaxy 5 w/ AC supply and speaker \$195.
Galaxy DC1000 mobile power supply \$25.
LS 400-12 12 volt power supply for Heath/others \$40.
Robot 800 teletype keyboard/TU-exc. condition \$375.
Collins 75A4 Rcvr. Exc. condition \$195.
Collins 755C3 receiver w/extra 14 socket crystal deck —
Serial #11997 — Mint \$350.
Drake TR 3 80-10 m xcvr. w/RV 3 ext. VFO, p.s. and spkr. in
matching cabinet. With DC power supply — all for \$350.
Hallicrafters SR 150 80-10 mtr. Xcvr., matching p/s,
spkr., mint condition \$195.
Drake TR4 AC/DC supply, ext. VFO, speech proc. Complete
Station \$375.
Clegg 22'er AC/DC 2 meter Xcvr. Good crystal lineup w/57w output. \$125.
Heath HW 2036 synth 2 mtr. FM \$125.
Heath SB 230 *4 hours on air* 80-10 meter 1200 watt
linear amplifier \$425.
Heath SB 101 w/p.s. & spkr. \$225.
Heath SB 102 w/matching supply, spkr., CW filter, VOX,
processor, new finals and driver, w/manual, digital
read out & freq. counter \$300.
Hallicrafters FPM 300 — 80-10 mtr. SSB, CW, AC/DC supply
with manual \$250.
Palomar freq. counter to 50 Mhz, AC/DC \$125.
**Wide selection of amateur antennas—base, mobile,
HF, VHF, UHF at reduced prices
We now stock Hygain, Hunter and KLM antennas**

The new ARRL "The FCC Rulebook" — \$3.00
"We handle anything electronic and love to trade"
Much more used & consignment gear — call for info

MEETING NOTICE

The July meeting of the Pikes Peak Radio Amateur Association will be held on July 6 at 7:30 p.m. at the **Palmer House Motel on N. Chestnut Street (just north of I-25 and Fillmore.)** The program is scheduled to cover the expanding field of amateur television and introduce the members to the equipment, procedures and results of this form of communication.

All members and other interested persons are encouraged to attend.

PACKET RADIO (cont.)

will be provided through the TAPR organization, and updates will be announced in the Packet Status Register bulletins.

Deposits for TNCs should be sent to: Tucson Amateur Packet Radio Corporation, P.O. Box 22888, Tucson, AZ 85734.

TAPR membership information may be obtained from the above address or from the address below.

Andy Freeborn N0CCZ
5222 Borrego Drive
Colorado Springs, CO 80918
303-598-8373
Beta Test Coordinator

SPORTS FESTIVAL

Well, the months of planning and all the hard work are over. National Sports Festival V was a rousing success, and we all can be proud of our contribution to the festival.

Although it did seem like there was very little to do at most of the events, the Venue Coordinators were glad to know that we were there in case they needed us.

The commemorative station handed out about 1500 contacts, and even got into Field Day a little, so we can say that the PPRAA was not totally out of Field Day this year. (Does this mean we have to go twice as hard next year?) W4ØVTU also handled traffic between athletes and their friends and families.

Thanks to all of you who gave of your time and effort to help out on this huge project. This goes to show that there still are many hams who take their radio privileges seriously, believe that nothing good comes for free, and want to show the public the kind of professional communications that amateurs are capable of.

**PPRAA PICNIC
AUGUST 7, 1983
EL PASO COUNTY PARK
(BLACK FOREST)
PAVILLION #1**